A REPORT ON THE ANIMAL REMAINS FROM THE 2009 ARCHAEOLOGICAL EXCAVATIONS AT VASINO IN EAST TIMOR.

BY

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INTRODUCTION

This report provides details of the zooarchaeological and taphonomic assessment of the animal remains recovered from the fortified settlement of Vasino, East Timor during the 2009 season of archaeological fieldwork. The study was undertaken between February and April 2011 on behalf of Professor Sue O'Connor and Jack Fenner of the Australian National University, Canberra.

The study was conducted to:

1. Evaluate the vertebrate remains recovered from the 2009 excavation of Vasino.
2. Gain insights into some key biostratinomic and post-depositional processes that have led to the accumulation and nature of preservation of the vertebrate remains on the site; and
3. Determine the potential contribution the vertebrate remains from Vasino might have for understanding the subsistence strategies, particularly animal husbandry, in historic sites in Island Southeast Asia and Wallacea.

ARCHAEOLOGICAL BACKGROUND

The following information on the archaeological background is derived from O'Connor *et al.*,(*in presss*)

Vasino is a two-level fortification complex situated on a hill top two kilometres inland from the north coast of East Timor, near the modern village of Parlamento-Moro. The lower level, which covers an area of about 1950 m^2 and has an elevation of 240 m, contains stone structures and markers and a wood pole (*ete uru ha'a*) of sacred importance. The stone markers were identified by local informants as the locations of graves. The lower level is bordered by a high, steep cliff on the west and by stone walls and shorter cliffs on the north and south. The upper level encompasses an area of 2740 m^2, with its eastern edge lined with a 2-4 meter deep natural gully with sharp edges. The northern boundary of the upper level is protected by a slope with a series of walls and termed as the Back Entrance. A stone walled space, known as *laca*, joins the two levels on the south side.

During the 2009 excavations, seven 1x1 m test pits labelled A – H (there was no Pit B excavated) were opened within the walled enclosure (Figure 1), with deposits reaching depths of 50-80 cm. AMS radiocarbon dates suggest that the site might have been built and settled during the 15^{th} century AD and local informants estimate that it has been abandoned for the last 200 years.

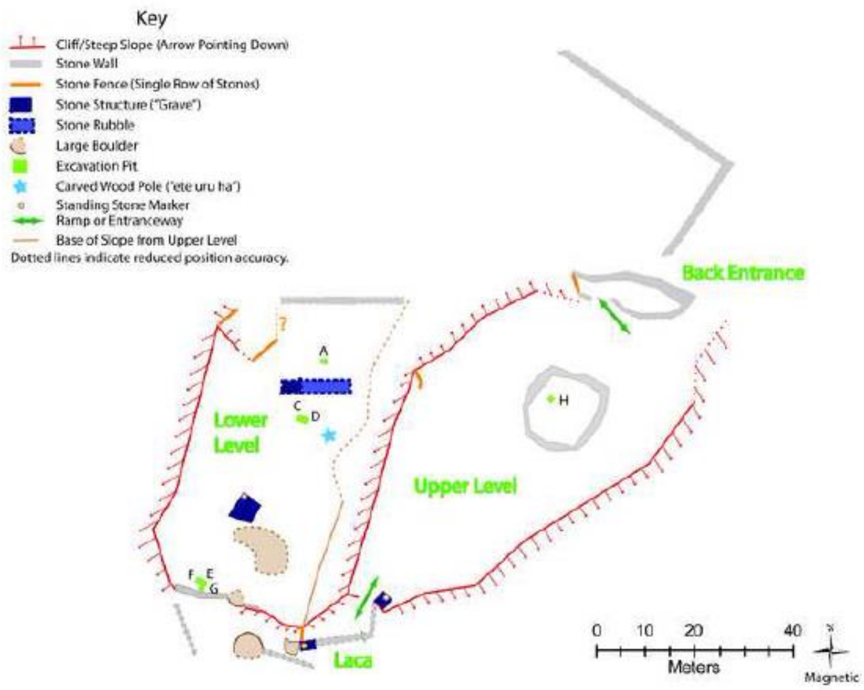

Figure 1: The location of excavated areas within the Vasino fortified settlement complex.

METHODOLOGY

All vertebrate remains collected from the 2009 excavations of Vasino were examined in this study. The maximum lengths of all fragments greater than 5 millimetres were measured, unless they showed evidence of modern breakage, to identify any spatial and temporal variability in fragment size that might provide information on taphonomic process. Taphonomic terminology follows Piper (2006; unpubl), modified from Lyman (1994). Important taphonomic and anthropic alterations, including weathering, burning, dog gnawing and butchery marks were recorded, and the location and orientation of human derived bone modifications (e.g. cut and chop marks) were recorded in detail.

Distinctive vertebrate elements were identified to Family, Genus or species using the modern comparative reference collection and digital database housed at the Archaeological Studies Program, University of the Philippines.

The criteria used for the biometric analyses of post-cranial elements follow von den Dreisch (1976). Whenever applicable, alternative measurements from diagnostic anatomical locales were used. Features that might indicate defects, for instance bone re-growth/ pathologies, were also recorded.

For caprid and suid teeth, a standard measurement for the length of the tooth was taken, and then the width of each molar column measured. All measurements were taken at, or as close to, the base of the enamel as possible, since goat and pig teeth change shape as they wear this location provides a point of reference where the analyst can be confident that all measurements of archaeological and comparative specimens will be comparable. To compensate for inter-analyst preferences, the lengths of the pig M1s and M2s were also measured at the occlusal surface (in brackets in Tables 3 and 5) so that they can be compared irrespective of which measurement has been used by other specialists. Pig aging from molar eruption and post-cranial fusion follows Bull and Payne (1982), and molar wear scales are based on those presented by Grant (1982).

All teeth, bones with key taphonomic and anthropic modifications and other selective elements were photographed and archived using a Nikon Coolpix Digital camera. Micrographs were also taken using the same camera mounted on a Nikon C-LEDS stereomicroscope.

Suid teeth were examined for any defects, particularly linear enamel hypoplasia (LEH). LEH is a defect acquired during the developmental stage of the molars that manifest as lines in the enamel surface. These defects are considered to indicate physiological stress, and in particular nutritional deficiencies, during the early growth of the animal (Dobney *et al.*, 2007). Pig molars were studied under a stereomicroscope and if any LEH defects were identified their height above the enamel-root junction was measured and recorded as specified by Ervynck & Dobney (1999).

Seven 1x1 m test pits were opened (A-H and excluding B) and then recorded by layer (1-9), e.g A1. Reference to the location of specific animal bones in this report uses these codes. During excavation rodent burrows and other disturbances were recorded in Pits A and D, and along with inversions in the radiocarbon dates within different stratigraphic horizons it is suggested that the spatial and temporal integrity of archaeological materials recovered from these pits has been compromised (Jack Fenner personal communication 2011). Analysis of the bone assemblages however, suggest that only minimal re-working might have occurred to the majority of the faunal remains, but the authors suggest that the chronological results presented here for the presence and absence of particular taxa within these pits should be treated with some caution. Nevertheless, the initial occurrence of the major identified taxa in Pit D (pig, Bovinae and goat) is supported by their early 15th Century AD presence in other pits and layers such as C4 strengthening the interpretive results of this study (see below for details). Furthermore, layers that are numerically the same in different pits are not necessarily chronologically correlated; that is D3 is not the same stratigraphic layer as F3. Thus reference to the different proportions of animal bones in different layers in the various pits reflects general spatial distribution and does not assume that the bones are of the same age.

RESULTS

Taphonomy: A total of 3023 bone fragments were recovered from Vasino during the 2009 excavation. Of these, 1495 (49.5%) were from Pit D, 490 (16.2%) from Pit C, 377 (12.5%) from Pit G, 262 (8.7%) from Pit F, 212 (7%) from Pit E, 94 (3.1%) from Pit A and 93 (3%) were from Pit H (Figure 2). The bones tend to concentrate in Layers 3 and 4, with more than 50% of the total vertebrate remains (Layer 3 = 776 or 25.7% and Layer 4 833 or 27.5%) found in these levels. Fifteen percent, 12.7 % and 9.6% of the bones were recovered from Layers 2, 5 and 1, respectively (Figure 3). Unlike trenches C, D E where the majority of bones were recovered from layers 2, 3 and/or 4 the highest counts of bones in trenches G and H are within the subsurface layers 1 and 2.

The vertebrate remains from Vasino were in varying states of preservation. The majority of the bone fragments were light yellowish brown to dark brown in colour. The bones have undergone varying degrees of weathering and abrasion, and some showed intense root etching. Most of the heavily weathered bones (71.7% of all weathered bone and 6.23% of the total number of bones analyzed) were found at subsurface levels (Figure 4). The heavily weathered bones were also found to concentrate in Pits F and G.

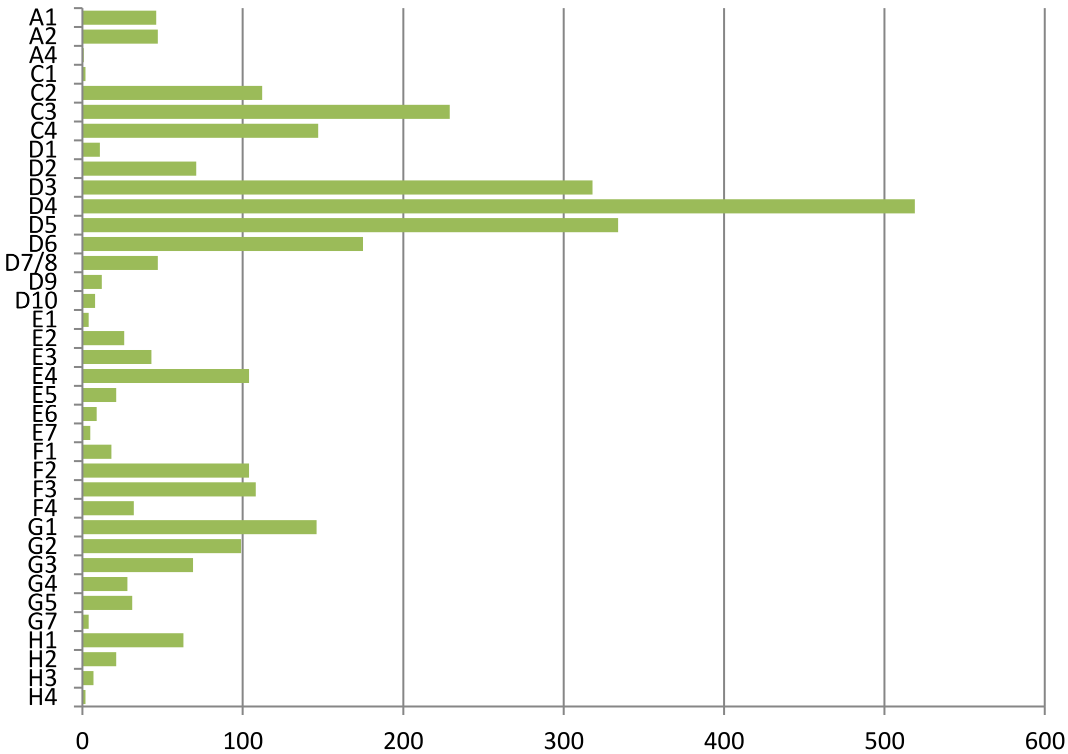

Figure 2: Distribution of the vertebrate remains in Pits A-H

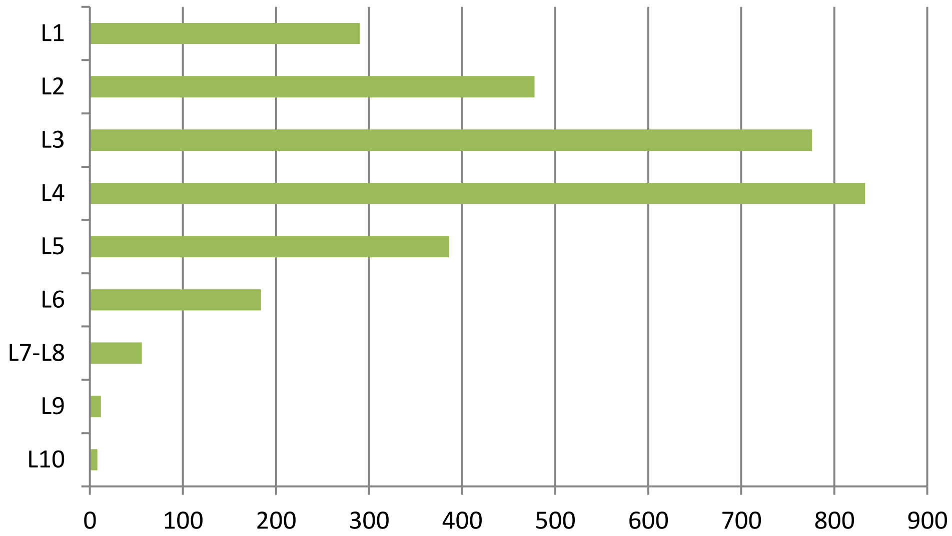

Figure 3: General distribution of vertebrate remains across layers

Slightly weathered bones, on the other hand, were found to be abundant in Pit D. Fifty seven percent (1735) of the bones analyzed were slightly weathered and 67.6% (1174) of these were recovered from Pit D. Numerous bones were also found to exhibit differential weathering on one surface or the other, suggesting that the bones have been left lying on the ground for sometime without disturbance prior to burial. For example, the ascending ramus of a bovid right mandible from D4 had a slightly weathered labial side and a heavily weathered lingual side with extensive root etching (Figure 5). These two taphonomic modifications indicate the mandible had lain with the lingual surface towards the ground and the labial side exposed to the elements.

Figure 5: An ascending ramus of a right bovid mandible exhibiting differential weathering on the labial and lingual surfaces.

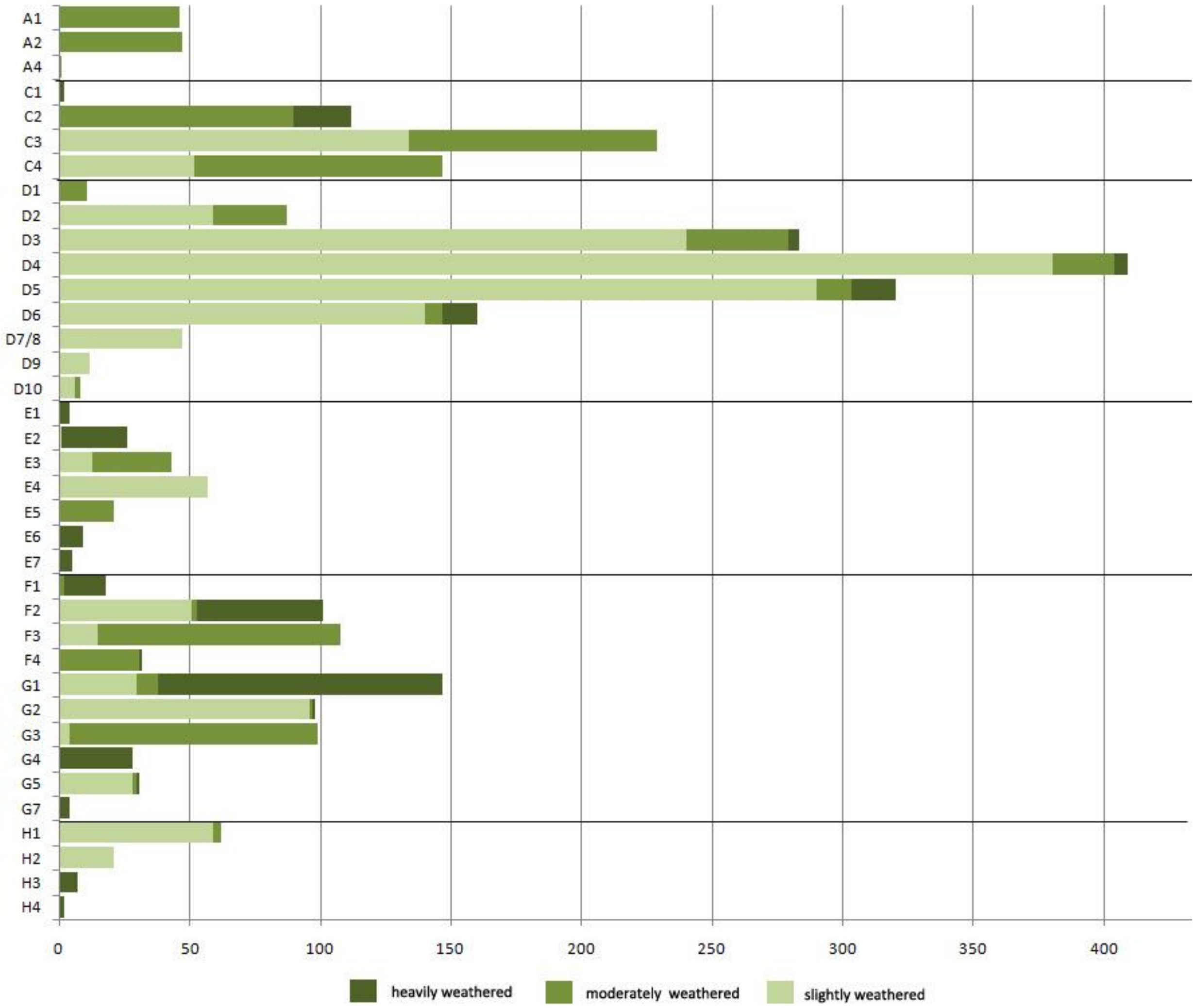

Figure 4: Distribution of vertebrate remains recovered from Vasino based on the degree of weathering.

It can be seen that more than half (53.7%) of the pieces analyzed measured less than 2 cm (Figure 6). On average, 78.9% of the bones recovered in each Pit measured less than 2 cm. The highest frequencies of these fragments were found in Pits A and H, where 92.6% and 83.4% of the bones recovered was less than 2 cm, respectively. In Pit D, where the majority of vertebrate remains in Vasino were recovered from, 58.6 % of the fragments were smaller than 2 cm. Thus, the identification of the elements was severely limited by the fragmentary nature of the bone assemblage.

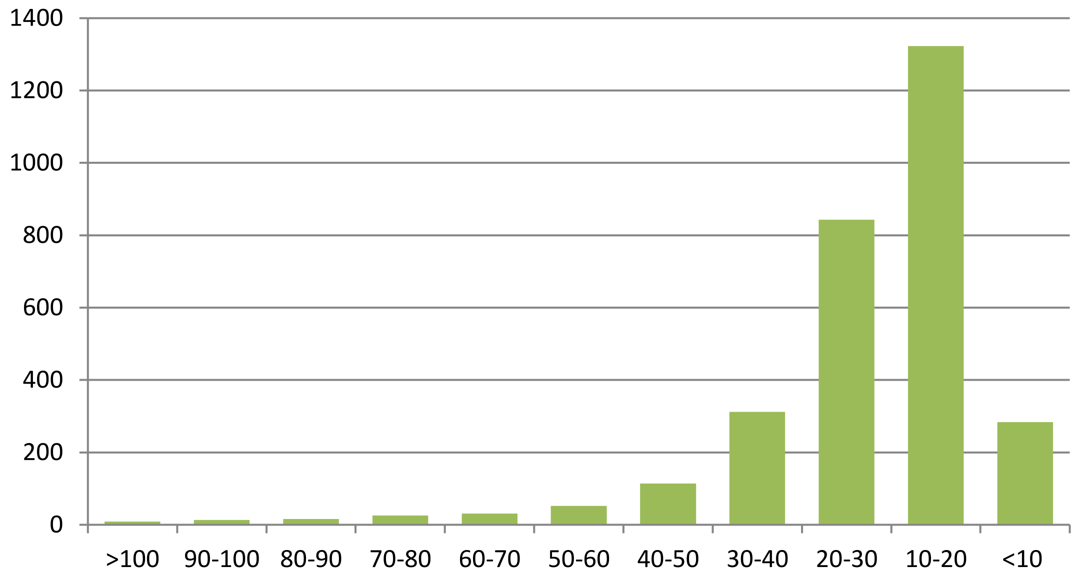

Figure 6: Measurements of the bone fragments recovered from Vasino

5.25% (159) of the bones analyzed showed evidence of burning. Majority of the burnt bones were found on Pit D (47.79%), Pit C (18.24%) and Pit G (4.4%). The proportion of burnt bones, similar to the proportion of bones with evidence of butchery, appears to correspond with the density of fragments recovered from the grid squares. All of the burnt fragments were unidentifiable to either taxon or element, save for a pig skull fragment from D3 and a bovid trapezoid from D5.

Evidence of butchery was recorded in 89 (2.99%) of the bone fragments examined. The majority of those with evidence of anthropic modification were found in levels 3 and 4 (Figure 7), and Pit D yielded most of the cut marked bones (70.51%) followed by Pits C (10.26%) and Pit E (7.69%). The proportion of bone with evidence of butchery in each grid square simply corresponds with the best levels of preservation and the greatest density of bone fragments, with Pits C and D, layers 3 and 4 producing some of the highest concentrations.

Butchery was identified in numerous identifiable skeletal elements of pigs, goats and Bovinae (Table 1). For example, three pig humeri from C3 and D5 and a goat right humerus from D4 have cut marks at various locations close to the distal articular end indicating severance of the muscle and tendons joining the humerus to the radius and ulna. The cut marks were identified on the antero-lateral surface (see Figure 9) and antero-medial surfaces of two different pig right humeri with unfused distal articular ends from D5, indicating that sub-adult pigs were clearly being slaughtered on site. Two transverse cut marks at the proximal end of a goat left radius was also probably caused by attempts to detach the upper and lower parts of the forelimb. Cut marks on the latero-ventral margins of two goat scapulae from D4 and a chop mark in a similar location on a pig left scapula from C2 results from separating the proximal end of the humerus from the scapula. Cut marks on the surfaces of cattle and goat calcanei from D5 and F3 respectively, is indicative of foot removal. The chop through the odontoid peg of a Bovinae axis in D4 is characteristic of decapitation, and cut marks on the lingual surface of a cattle mandible from the same layer could have resulted from tongue removal. Cut and chop marks in and around the proximal articular ends of ribs is probably related to sectioning either at the articulation with the vertebrae or through the intercostals.

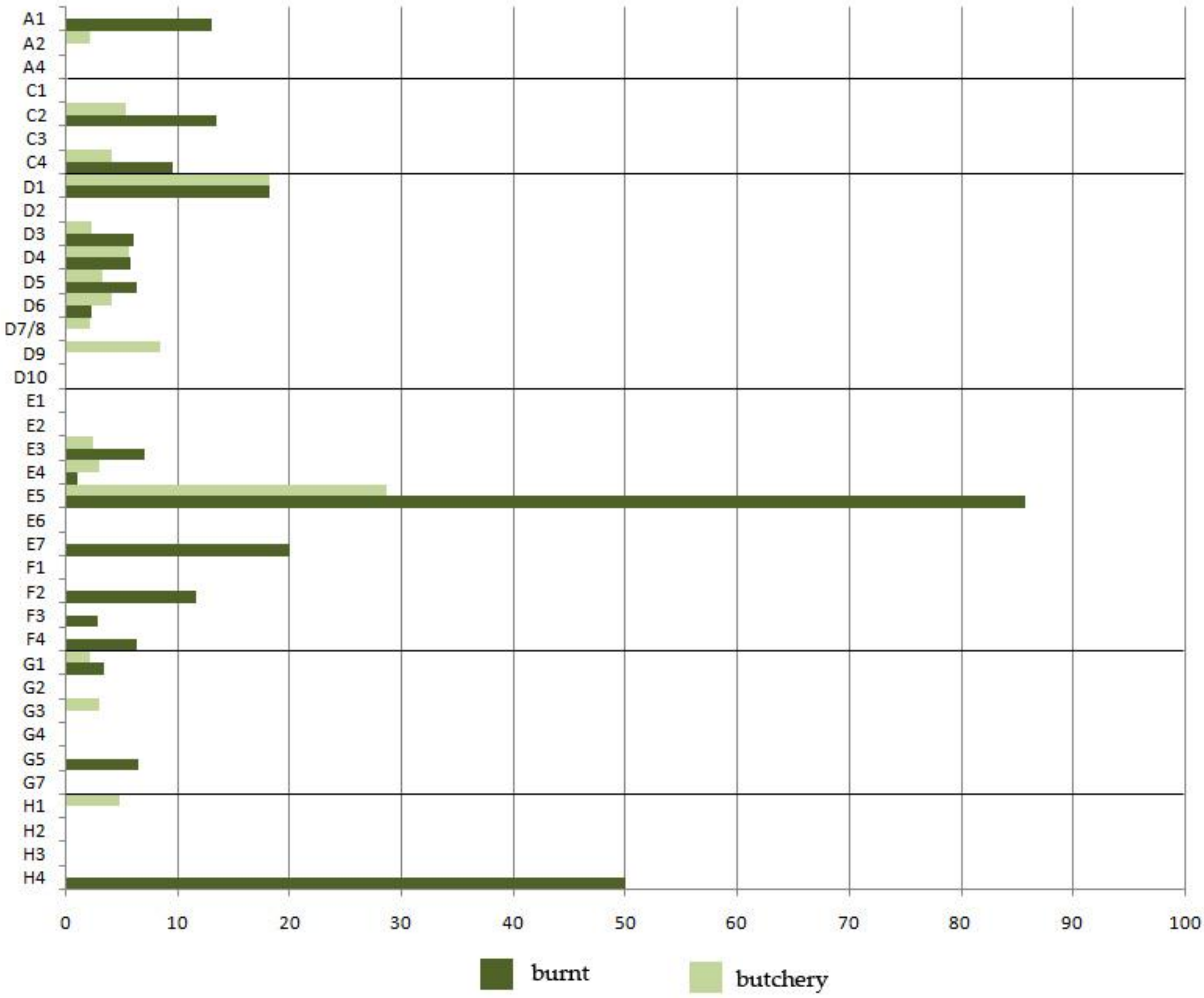

Figure 7: Proportion of bone fragments with evidence of burning and butchery

The presence of high meat yielding skeletal elements such as the scapula, humerus, pelvis, vertebrae and femur, and low utility portions of the skeleton like the lower limbs (e.g. calcanei, metapodials and phalanges) implies that whole carcasses were being introduced to the site and dressed.

Table 1: A list of the types, locations and orientation of butchery marks in the bones that could be identified to taxon.

Grid./Layer	Taxon	Skeletal element	Remaining fragment	Side	Type, location and orientation of butchery marks
C2	*Sus* sp. (domestic)	Scapula	Glenoid fossa and neck	L	2 x oblique chop marks on the ventral margin
C3	*Sus* sp. (domestic)	Humerus	Distal diaphysis	R	2 x oblique cut marks on postero-lateral margins
D5	*Sus* sp. (domestic)	Humerus	Distal diaphysis	L	2 x transverse cut marks on the medial and lateral surfaces
D5	*Sus* sp. (domestic)	Humerus	Distal diaphysis	R	1 x transverse cut mark on the antero-medial surface
C3	Bovinae	Rib fragment	Shaft fragment	N/A	2 x cut marks on the medial surface and 1 x chop mark on the dorsal margin and another on the lateral surface
C4	Bovinae	Lumbar vertebra	Neural arch	N/A	1 x transverse cut mark on the spine
D4	Bovinae	Axis	Fragment of ventral arch and body	N/A	Chop mark at the cranial end through the odontoid peg and another on the ventral surfaces cranial to the ventral arch.
D4	Bovinae	Rib fragment	Proximal end	N/A	3 x dorso-ventral orientated cut marks on the medial surface close to articular end
D4	Bovinae	Mandible	Ascending ramus	R	2 x transverse cut marks on the lingual surface

D4	Bovinae	Rib fragment	Shaft fragment		1 x dorso-ventral orientated cut mark on the medial surface
D5	Bovinae	Rib fragment	Shaft fragment		3 x transverse cut marks on the medial surface
D5	Bovinae	Calcaneus	Complete (unfused proximal end)	L	3 x transverse cut marks on the dorso-lateral surface
D5	Bovinae	Metacarpal	Distal end	L	1 x transverse cut mark on the ventral surface
D5	Bovinae	Rib fragment	Shaft fragment	N/A	1 x transverse cut mark on the medial surface near the break
C3	*Capra aegagrus hircus*	Radius	Proximal diaphysis	L	2 x transverse cut marks on the anterior surface close to the articular end
C3	*Capra aegagrus hircus*	Humerus	Distal diaphysis	L	2 x cut marks on the postero-lateral margins
D4	*Capra aegagrus hircus*	Scapula	Ventral margins of the glenoid fossa and neck	R	Oblique cut mark on the latero-ventral surface
D4	*Capra aegagrus hircus*	Scapula	Ventral margins of the glenoid fossa and neck	R	Oblique cut mark on the latero-ventral surface
D4	*Capra aegagrus hircus*	Humerus	Distal end of the shaft, posterior fragment	R	1 x transverse cut mark - postero-lateral marginjust above the location of the lateral epicondyle which is missing.
F3	*Capra aegagrus hircus*	Tibia	Distal end	L	2 x transverse cut marks on the antero-medial surface and 1 x cut mark on the antero lateral surface
F3	*Capra aegagrus hircus*	Calcaneus	Almost complete	R	2 x oblique cut marks on the dorso-lateral surfaces

Table 2: The Number of Identified Specimens (NISP) of different vertebrate taxa recovered from Vasino

Class	Order	Family	Taxon	Common Name	**NISP**
Teleosteii (Superclass)					13
	Perciformes	Serranidae		Sea bass/Grouper	1
Reptilia	Squamata	Serpentes (Suborder)	Serpentes	Snake	1
	Testudines	Chelionoidea		Sea turtle	1
Aves	Passeriformes (?)				1
Mammalia	Primates	Cercopithecidae	*Macaca fascicularis*	Long tailed macaque	4
	Carnivora	Canidae	*Canis familiaris*	Domestic dog	8
	Artiodactyla	Suidae	*Sus* cf. *scrofa* (domestic)	Domestic pig	95
		Cervidae	*Rusa* cf. *timorensis*	Deer	5
		Bovidae	Bovinae (Subfamily)	Cattle/Buffalo	63
		Bovidae	*Bubalus bubalis*	Buffalo	1
		Bovidae	*Bos* sp.	Cattle	2
		Bovidae	*Capra aegagrus hircus*	Domestic goat	87

Table 3: The Number of Identified Specimens recorded by pit and layer recovered from Vasino: *Macaca f.* = *Macaca fascicularis*; *Canis f.* = *Canis familiaris*; *Capra a.h.* = *Capra aegagrus hircus;* *Bovinae – includes both *Bos* sp. and *Bubalus bubalis*

	Taxon									
Square/Layer	Teleosteii	Testudines	Serpentes	Aves	*Macaca f.*	*Canis f.*	*Sus* cf. *scrofa*	*Rusa* cf. *timorensis*	Bovinae*	*Capra a.h.*
A1	\	\	\	\	\	\	1	\	\	\
A2	\	\	\	\	1	\	\	\	2	\
A4	\	\	\	\	\	\	\	\	\	\
C1	\	\	\	\	\	\	\	\	\	\
C2	\	\	\	\	\	\	3	\	1	4
C3	\	\	\	\	\	1	16	\	4	9
C4	\	\	\	\	\	\	8	\	6	4
D1	\	\	\	\	\	\	\	\	\	\
D2	\	\	\	\	\	1	1	2	1	\
D3	\	\	\	\	\	1	5	1	2	8
D4	\	\	\	\	\	1	21	1	22	21
D5	1	\	\	\	1	1	18	1	13	6
D6	4	\	\	\	\	2	10	\	4	11
D7/8	2	\	\	\	\	\	1	\	1	\
D9	1	\	\	\	\	\	\	\	1	\
D10	\	\	\	\	\	\	\	\	\	\
E1	\	\	\	\	\	\	\	\	\	\
E2	1	\	1	\	\	\	\	\	\	3
E3	\	\	\	\	\	\	\	\	2	2
E4	\	\	1	\	\	\	1	\	\	3

E5	\	\	\	\	\	\	\	\	\	\
						Taxon				
Square/Layer	Teleosteii	Chelionoidea	Serpentes	Aves	*Macaca f.*	*Canis f.*	*Sus* cf. *scrofa*	*Rusa* cf. *timorensis*	Bovinae*	*Capra a.h.*
E6	\	\	\	\	\	\	\	\	\	\
E7	\	\	\	\	\	\	\	\	\	\
F1	\	\	\	\	\	\	\	\	1	\
F2	\	\	\	\	1	\	3	\	3	4
F3	2	\	\	\	\	\	1	\	1	3
F4	\	\	\	\	\	\	\	\	\	1
G1	\	\	\	\	\	\	2	\	\	2
G2	\	\	\	\	\	1	\	\	2	\
G3	\	1	\	1	\	\	4	\	\	5
G4	1	\	\	\	\	\	\	\	\	\
G5	\	\	\	\	\	\	\	\	\	1
G7	\	\	\	\	\	\	\	\	\	\
H1	\	\	\	\	\	\	\	\	\	\
H2	\	\	\	\	1	\	\	\	\	\
H3	\	\	\	\	\	\	\	\	\	\
H4	\	\	\	\	\	\	\	\	\	\

Species representation: Mammals account for 265 (93.97%) of all the identified vertebrate remains and 8.77% of the total number of bones recovered, with a few fish (0.46%) and reptile (0.04%) remains were also recovered (Tables 2 & 3).

Of the 95 pig remains recovered, the majority consisted of loose teeth. Pigs were recovered from C4 the earliest recognized stratigraphic units of the site. A minimum of four individuals could be identified based on right distal shafts of humeri. Three individuals could be determined from nine mandibular fragments and left maxillary dp4s (Tables 4 & 5). For example a pig left maxilla from D4 still retained its dp3, dp4 and M1 all of which were relatively unworn and probably from an individual not more than 6 months of age (Figure 8). A loose upper dp4 from G3 still had its roots indicating that it had not been naturally shed and is from an individual killed between 12 and 18 months. Other specimens had a fully erupted but unworn M2 (e.g. from D5 and D6) and unworn P4 and M1. A loose and fragmented M3 from C3 has no roots and is clearly still in the developmental stages and from a young individual. A left mandible from D4 contained an erupted and in wear M2 and a partially impacted and worn M3. This represents the oldest individual recorded in the assemblage at more than three years of age (see Figure 10). The presence of numerous dp4s, unworn P4s, M1s, unerupted or unworn M2s and rarity of M3s indicate that majority of the specimens (mandibular and maxillary) recovered did not exceed 18 to 22 months of age at death, with most probably slaughtered within the first 12 - 18 months of life (Habermehl, 1975; Bull & Payne, 1982).

Comparisons of tooth measurements with *Sus scrofa* specimens from Mainland Asia suggest that the specimens from Vasino show considerable size diminution over their wild progenitors (Table 6). For example the length of the maxillary M1s in the Vasino assemblage range from 13.30 - 14.59 mm compared to 15.71 – 16.03 mm in the modern specimens of *Sus scrofa* from China. A similar size diminution is evident in the mandibular and maxillary dp4s and M2s. The measurements are also significantly smaller compared to those from *Sus celebensis* (Genov, 2004), a translocated wild pig species present on Timor. The predominance of juvenile and sub-adult pigs in combination with size reduction is a good indication that the pigs from Vasino represent a managed, domestic population but some individuals could still conceivably represent hunted feral animals.

The age profile established from the dentition is supported by a number of unfused post-cranial elements recovered. Six humeri (three lefts and three rights) with unfused distal epiphyses from D4, D5 and G3 are from at least three individuals of less than 12 – 18 months of age. A complete radius from D7 with both articular ends unfused is from an individual of less than 12 months of age, a basal lateral phalanx from C4 with unfused proximal end, and small right calcaneus in C2 were also from at least one sub-adult individual. Based on size, the left and right femoral shaft fragments with unfused proximal and distal ends from D4 and D5 are also likely to be from sub-adult individuals. However, the recovery of a basal phalanx with fused proximal end and a right 4th metacarpal with fused distal epiphysis does indicate an individual of more than two years old is also present in the assemblage. Cut marks were identified on the lateral aspect of an unfused right distal humerus from D5, suggesting that sub-adult pigs were being slaughtered (Figure 9)

Figure 8: Pig left maxillary fragment from D4 with retained dp3, dp4 and M1

Linear enamel hypoplasia was not observed in any of the pig molars examined. A right mandibular specimen from D4, however, was found to have a partial bony impaction (Figure 10). The mandible contained the M2 and the M3, with the M3 partially erupted at right angles to the normal position. The M3's anterior cusps were at the occlusal plane and the tooth slopes steeply from the labial to lingual side, with the posterior cusps still within the crypt. The cranial surfaces of the M3 were in wear indicating the individual was at least three years of age at death, even though the tooth had a 90 degree wrong orientation and the mandible was slightly malformed. The anterior roots of the tooth were also small and weakly formed.

Table 4: The length and breadth measurements (mm) of the maxillary and mandibular dp4s to M2s of the pigs recovered from Vasino (measurements in brackets for the M1 and M2 were taken at the occlusal surface, those without brackets are measurements at the enamo-root junction); l = length, Ba = breadth of anterior cusps, Bm = breadth of middle cusps (dp4 and M3 only), Bp = breadth of posterior cusp

Sq/Layer	Side	dp4l	dp4Ba	dp4Bm	dp4Bp	P4l	P4b	M1l	M1Ba	M1Bp	M2l	M2Ba	M2Bp
Mandible													
C3	L	\	5.88	6.91	\	\	\	\	\	\	\	\	\
D4	L	\	\	\	\	\	\	\	\	\	15.24 (16.39)	12.66	12.02
D5	L	15.96	5.63	6.39	7.85	\	\	\	\	\	\	\	\
D5	L	\	\	\	\	\	\	14.26	8.58	9.18	\	\	\
Maxilla													
C3	L	\	\	\	\	\	\	14.59 (14.92)	10.37	10.48	\	\	\
D4	L	11.25	10.26	NA	9.02	\	\	13.30	10.51	9.69	\	\	\
D4	R	12.54	10.17	NA	9.89	\	\	\	\	\	\	\	\
D5	L	\	\	\	\	11.03	11.01	13.94	11.21	11.43	17.89 (18.42)	14.94	14.73
D6	L	\	\	\	\	\	\	\	\	\	17.17 (18.05)	14.09	14.8
E4	R	13.43	8.01	NA	9.19	\	\	\	\	\	\	\	\
G3	R	11.94	9.99	NA	9.89	\	\	\	\	\	\	\	\

Table 5: Tooth eruption and wear stages (after Grant, 1982) for the pig mandibular and maxillary dp4 and P4 to M2 from Vasino. *Note: The mandibular M1 from D4 had a damaged caudal end so no measurements were taken.

Vasino Sq/Layer	Side	dp4	P4	M1	M2
		Tooth Eruption/ Wear			
Mandible					
C3	L	A			
D4	L				F
D4*	?			M	
D5	L	D			
D5	L			A	
Maxilla					
C3	L			C	
D4	L	B		A	
D4	R	B			
D5	L		A	B	A
D6	L				B
E4	R	C			
G3	R	A			

Figure 9: Unfused right distal humerus from D5 with cut marks on the lateral surface of the lateral epicondyle.

Table 6: The length and breadth measurements (mm) of the maxillary and mandibular dp4s to M2s of *Sus scrofa* from China held in the Field Museum of Natural History, Chicago and UP Archaeological Studies Program Reference Collection (data P.J. Piper, N. Amano and J. Ochoa; measurements in brackets for the M1 and M2 were taken at the occlusal surface, those without brackets are measurements at the enamo-root junction): None of the individuals were adult, and the M3 was unerupted; l = length, Ba = breadth of anterior cusps, Bm = breadth of middle cusps (dp4 and M3 only), Bp = breadth of posterior cusps, Er = erupting, uner = unerupted.

Accn No.	Locality	Sex	dp4L	dp4Wa	dp4Wm	dp4Wp	P4L	P4W	M1L	M1Wa	M1Wp	M2L	M2Wa	M2Wp
Mandible														
39326	Shanxi, China	F	17.43 (18.19)	5.05	6.99	8.66	\	\	15.36 (16.66)	10.1	11.43	\	\	\
31799	Laos, Pong Saly	M	\	\	\	\	13.43	10.26	16.48 (17.77)	12.83	13.18	19.95 (20.61)	17.33	16.98
39327	Szechwan, China	?	18.04 (19.21)	6.54	7.98	8.9	\	\	15.9 (16.91)	\	\	\	\	\
31791	Annam, French Indo-China	M	\	\	\	\	14.71	12.29	17.75 (18.32)	13.8	13.7	22.91	19.16	18.42
A-100	Laguna, Philippines	F	17.97 (18.21)	\	7.6	8.78	17.45	10.94	\	\	\	\	\	\
A-003	Manila, Philippines	?	\	\	\	\	17.23	10.97	18.97 (19.23)	11.15	12.4	\	\	\
A-054	Manila, Philippines	?	17.48 (18.56)	6.38	7.07	8.07	16.73	11.21	\	\	\	\	\	\
Maxilla														
39326	Shanxi, China	F	12.37 (13.8)	10.42	\	11.15	\	\	16.03 (16.98)	13.6	13.4	\	\	\
31799	Laos, Pong Saly	M	\	\	\	\	12.78	14.44	15.71 (17.74)	15.99	15.77	20.82 (23.94)	20.55	19.9
39327	Szechwan, China	?	12.75 (13.35)	10.58	\	11.41	\	\	16.02 (16.98)	13.17	13.37	\	\	\
31791	Annam, Indochina	M	\	\		\	13.81	16.51	17.15	16.61	17.77	22.87	21.5	22.4
A-059	Manila, Philippines	?	11.34	6.2		8.11	12.65	11.91	\	\	\	\	\	\
A-100	Manila, Philippines	?	11.21 (11.57)	7.92		8.33	13.33	10.78	15.57 (16.78)	11.58	11.97	\	\	\

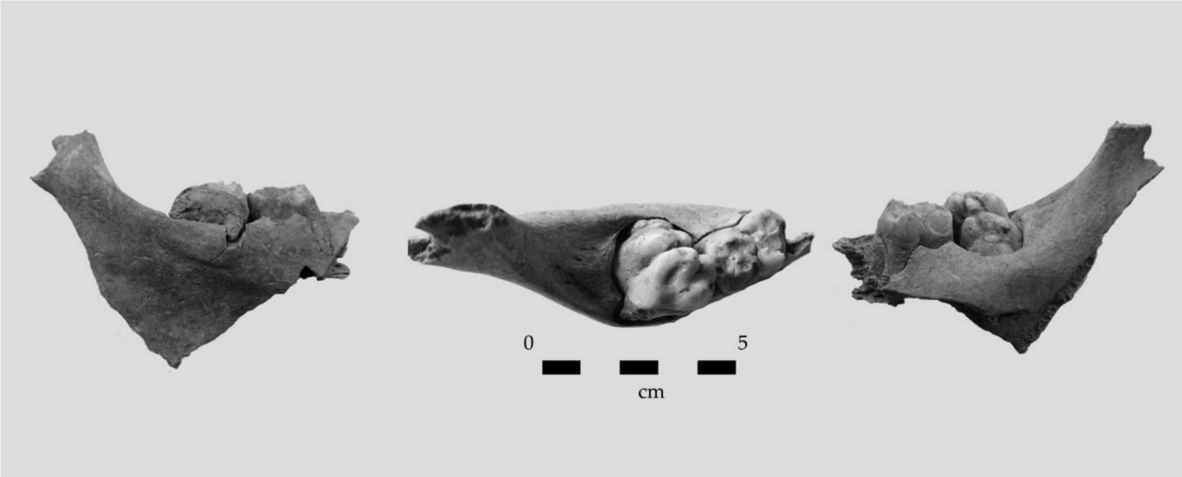

Figure 10: Right pig mandible from D4 showing partial bony impaction. The impacted and worn M3 represents the oldest individual recovered from Vasino.

Eighty seven fragments of caprid were recovered from Vasino from the topsoil (G1) to the lowest levels in D6, and in some of the earliest recognized deposits such as C4 (Table 3). Although the remains of sheep and goats are difficult to distinguish in the archaeological record, the domestic goat (*Capra aegagrus hircus*) is the only taxon to have beeen introduced into Island Southeast Asia until very recently and all the caprid remains from Vasino are considered to come from this taxon. Teeth were the most common of the goat remains recovered (37.9% considering complete elements and 57.5% including fragments) followed by the calcaneus (6.9%), radius (5.7%) and metapodials (5.7%). A minimum of three individuals could be identified based on the 22 complete teeth (3 left mandibular M1s and 3 lower left P3s) and post-cranials (3 pairs of right and left calcanei and 3 left astragali) recovered. Thus, there is no great difference in the numbers of pig and goat bones entering the archaeological record. Only two dp4s were identified in C3 and C4, and both were heavily worn (Grant Stage J and F; Table 7). Other specimens included two only slightly worn left and right mandibular M1s (possibly from the same individual) in G3, moderately to heavily worn mandibular and maxillary M1s and M2s in C3, D3, D4, D5, D6 and G3 (Tables 6 and 7). A single unerupted right maxillary M3 was identified in D4, and three slightly – moderately worn left and right M3s were recovered from C3, D3 and D4. Hillson (2005) noted that there is considerable variation in the eruption timing of the teeth of different domestic goat breeds, but the moderately to heavily worn nature of the M1s and M2s and worn M3s would suggest several individuals probably older than 24 months (Moran & O'Connor, 1994). The tooth wear analysis suggests individuals from relatively young to quite old were being slaughtered on the site.

Table 7: Tooth eruption and wear stages (after Grant, 1982) for the goat mandibular and maxillary dp/4 and P4 to M3 from Vasino. *Note: The mandibular M1 and P4 from F2 had damaged occlusal surfaces.

Vasino		**Tooth Eruption/Wear**				
Sq/Layer	**Side**	**dp4**	**P4**	**M1**	**M2**	**M3**
Mandible						
C3	L	J				
C3	L				M	
C4	?	F				
D3	R			H		
D3	R				G	
D3	R					C
D4	L			G		
D6	L		Uner			
G3	L			A		
G3	R			A		
Maxilla						
C3	R				H	
C3	R					G
D4	L				H	C
D4	R					Uner
D4	R				F	
D5	R			G		
D6	R			B		
D6	L				A	
E4	R		A			
G3	R			F		

The fused postcranial elements supported the age profile derived from the dentition. A fused distal metacarpal recovered from E4 suggests the presence of an individual older than 24 months. Other elements found useful for aging included proximal sub-terminal phalanges and articular end of scapula from D4 (fusion ~19 months), proximal femur from C3 (fusion ~24 months female, 36 months feral male), distal metatarsal (~23-30 months) and distal tibia from E2 (~19-24 months). Thus, based on bone fusion most of the goats were greater than two years of age at the time of death. A calcaneus with an unfused distal end from C3 and a metacarpal also with an unfused distal end represent individuals that did not reach 24 months.

The dental measurements were not significantly different from those taken from domestic goat materials kept at the University of the Philippines, Archaeological Studies Program (Tables 8 & 9), save for the mandibular M2s

Table 8: The length and breadth measurements (mm) of the maxillary and mandibular dp4s to M3s of the goats recovered from Vasino (measurements taken at the enamo-root junction); l = length, Ba = breadth of anterior cusps, Bm = breadth of middle cusps (dp4 and M3 only), Bp = breadth of posterior cusps.

Sq/Layer	Side	dp4l	dp4Ba	dp4Bm	dp4Bp	P4l	P4b	M1l	M1Ba	M1Bp	M2l	M2Ba	M2Bp	M3l	M3Ba	M3Bm	M3Bp
Mandible																	
C3	L	13.85	4.92	5.9	6.91	\	\	\	\	\	\	\	\	\	\	\	\
C3	L	\	\	\	\	\	\	12.06	10.46	-	\	\	\	\	\	\	\
C4	L	14.07	\	6.03	\	\	\	\	\	\	\	\	\	\	\	\	\
D3	R	\	\	\	\			11.06	7.11	7.84	\	\	\	\	\	\	\
D3	R	\	\	\	\	\	\	\	\	\	13.55	8.12	8.39	\	\	\	\
D3	R	\	\	\	\	\	\	\	\	\	\	\	\	20.4	8.13	8.08	4.02
D4	L	\	\	\	\	\	\	10.02	5.71	5.78	\	\	\	\	\	\	\
D6	L	\	\	\	\	11.3	6.3	\	\	\	\	\	\	\	\	\	\
F2	R	\	\	\	\	10.17	6.79	\	\	\	\	\	\	\	\	\	\
F2	L	\	\	\	\	\	\	11.19	6.94	7.49	\	\	\	\	\	\	\
G3	L	\	\	\	\	\	\	10.72	7.16	7.14	\	\	\	\	\	\	\
G3	R	\	\	\	\	\	\	11.24	-	-	\	\	\	\	\	\	\
Maxilla																	
C3	R	\	\	\	\	\	\	\	\	\	16.47	8.2	8.4	\	\	\	\
C3	R	\	\	\	\	\	\	\	\	\	\	\	\	17.54	12.46	NA	11.47
D4	L	\	\	\	\	\	\	\	\	\	17.57	14.73	12.69	19.68	13.16	NA	12.05
D4	R	\	\	\	\	\	\	\	\	\	\	\	\	20.41	15.81	NA	13.28
D4	R	\	\	\	\	\	\	\	\	\	18.84	15.55	16.82	\	\	\	\
D5	R	\	\	\	\	\	\	12.1	11.26	10.63	\	\	\	\	\	\	\
D6	R	\	\	\	\	\	\	14.25	10.19	6.25	\	\	\	\	\	\	\
D6	L	\	\	\	\	\	\	\	\	\	16.43	8.71	8.82				
E4	R	\	\	\	\	7.69	6.64	\	\	\	\	\	\	\	\	\	\
G3	R	\	\	\	\	\	\	12.82	11.47	10.35	\	\	\	\	\	\	\

Table 9: The length and breadth measurements (mm) of the maxillary and mandibular dp4s to M3s of the goats maintained at the UP-ASP Zooarchaeology Reference collection ; l = length, Ba = breadth of anterior cusps, Bm = breadth of middle cusps (dp4 and M3 only), Bp = breadth of posterior cusps.

Code	Sex	dp4l	dp4Ba	dp4Bm	dp4Bp	P4l	P4b	M1l	M1Ba	M1Bp	M2l	M2Ba	M2Bp	M3l	M3Ba	M3Bm	M3Bp
Mandible																	
A-001	F	\	\	\	\	10.21	6.21	12.45	6.82	7.34	\	\	\	\	\	\	\
A-105	M	13.62	5.17	5.41	6.67	\	\	12.45	7.05	8.21	14.81	6.84	6.31	\	\	\	\
A-034	?	\	\		\	9.88	6.85	11.55	6.96	7.64	14.25	7.33	7.84	20.13	7.79	6.70	4.45
Maxilla																	
A-001	F	\	\	\	\	7.83	6.66	12.58	10.48	9.54	13.72	8.85	7.68	\	\	\	\
A-105	M	9.84	9.72	\	8.19	\	\	14.64	9.56	7.89	14.83	7.42	8.76	\	\	\	\
A-034	?	\	\	\	8.89	8.92	9.54	12.47	10.54	9.37	13.92	10.09	8.87	15.72	8.57	7.23	\

and M3. The M2s and M3 recovered from Vasino are significantly larger compared to those in the reference collection.

Large Bovinae, either *Bos* or *Bubalus*, made up 23.5% (NISP = 66) of the identified vertebrate remains in the Vasino bone assemblage. An upper left M2 from D4 was identified as belonging to the water buffalo (*Bubalus bubalis*; Figure 11A). Two teeth, an upper left M1 from D4 and a lower left M3 from E3, on the other hand, were identified with confidence as belonging to cattle *Bos* sp. (Figure 11B).

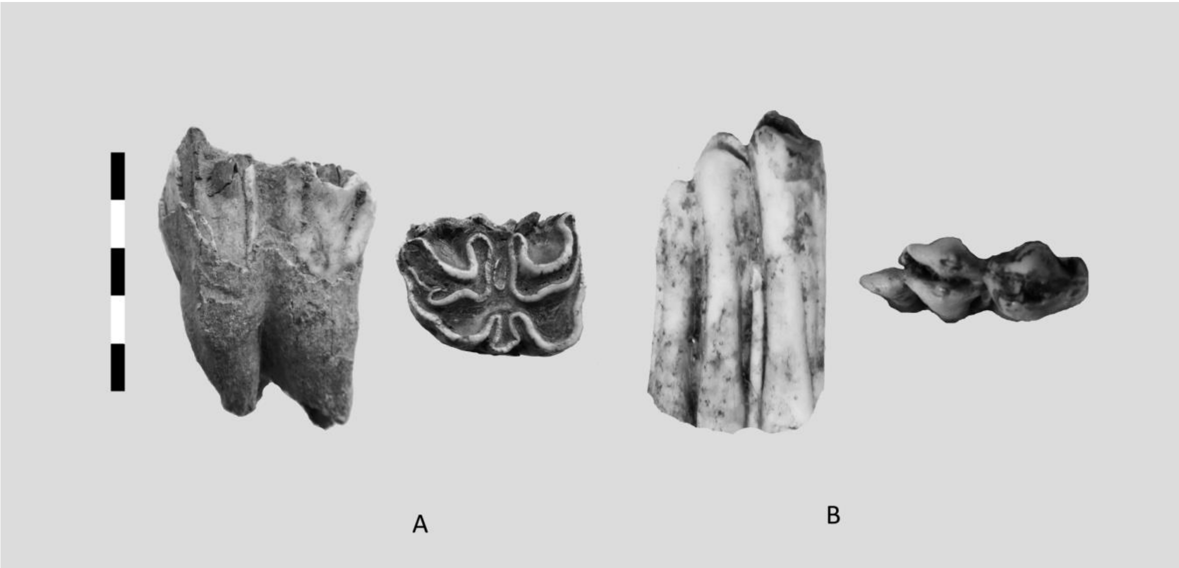

Figure 11. An upper left M2 from *Bubalus bubalis* recovered from D4 (A) and lower right *Bos* sp. M3 from E3 (B) (Scale in cms).

The majority of the large Bovinae remains were from Pit D (68.18%) followed by Pit C (19.69%), which generally had the highest concentrations of identifiable bones. No Bovinae remains were recovered below Layer 3 in Pits E, F and G and in all layers in Pit H. Most of the Bovinae remains were teeth (34.3%), followed by ribs (19.5%) and vertebral fragments (13.3%).

Aging data is scarce for Bovinae, but a heavily worn upper left M1 was recovered together with a moderately worn left maxillary M2 from D4 (possibly from the same individual). An unerupted mandibular M3 was recovered from E3 was probably less than two years of age, and a *Bos* M3 from D4 which was still in the process of eruption when the animal died suggests that it was slaughtered within the second year of its life. A left tibia with an unfused distal epiphysis from D3 and a metacarpal with an unfused distal end from D5 were probably from relatively young individuals of less than 28 – 32 months of age (Silver, 1970). No bones from juvenile or neonate Bovinae were found. This suggests that the assemblage consists primarily of sub-adult and adult Bovinae.

In total, five deer remains were recorded (1.77% of the identified elements). The remains probably represent *Rusa timorensis*, the Sunda Sambar, which is the only deer species native to East Timor. The deer skeletal elements comprise a pair of P2 (Figure 12), a maxillary P3, basal phalanx, and proximal radius were all recovered from Pit D, in levels 2, 3, 4 and 5 respectively. Since the few deer remains were either damaged or covered in concretion, no measurements or tooth attrition data that could be used for size or age estimation were taken.

Figure 12: Heavily worn deer P2 recovered from D2

A total of eight dog bones from at least two individuals (based on two right mandibular M3s) were recorded in the assemblage. Dog is represented in G2 by a fragment of parietal bone. The rest, a right mandible with P4-M2 (D5) (Figure 13), left mandibular M1 (D3) and M2 (D2), right lower M3 (D4) and fourth metacarpal (unsided; D5) were all from Pit D. The worn M3 from D3 is from an individual of at least three years of age (Van Bree *et al.*, 1974). The tooth measurements were not significantly different from the dental measurements of Philippine dogs from the UP ASP reference collection (Table 9). No butchery marks were found in any of the dog bones examined.

Although dog bones were not abundant, dog-gnawed and digested bones were relatively common with 26 (0.86%) elements recorded. A pig humerus from C4, a caprid radius from C5 and calcaneus and tibia from F3 exhibited heavy gnawing. A caprid astragalus from F2 (Figure 14) demonstrated the characteristic signs of partial digestion and/or regurgitation: corroded, acid-etched surface and a shrunken appearance (Davis, 1985; Payne & Munson, 1985). Partially digested bones by viverids show little corrosion and rounding (Andrews & Nebit-Evans, 1983) and the absence of other moderately-sized carnivores in the assemblage makes it safe to presume that the element was ingested by a dog. A caprid right calcaneus from D4 also exhibited evidence of dog modification (Figure 15). It has isolated indentations on the medial and lateral sides resulting from compression of the bone, and a pit on the medial side, caused by dog canines. The diameter of the pit (8.02 mm) fits in the range of the upper canine diameter of the dog reference materials maintained at UP-ASP (7.32-8.78 mm, 8.33 mm average). The inward compression suggests that the pit was created when the bone was fresh.

Fish bones represent only 4.96% of the identified vertebrate remains and 0.46% of all the bones recovered. Most of the elements were cranial fragments and a few vertebrae and spines. Only one element was identified to family level, a maxillary fragment from a Serranidae from G4.

Figure 13: A dog right mandible with P4-M2 from D5

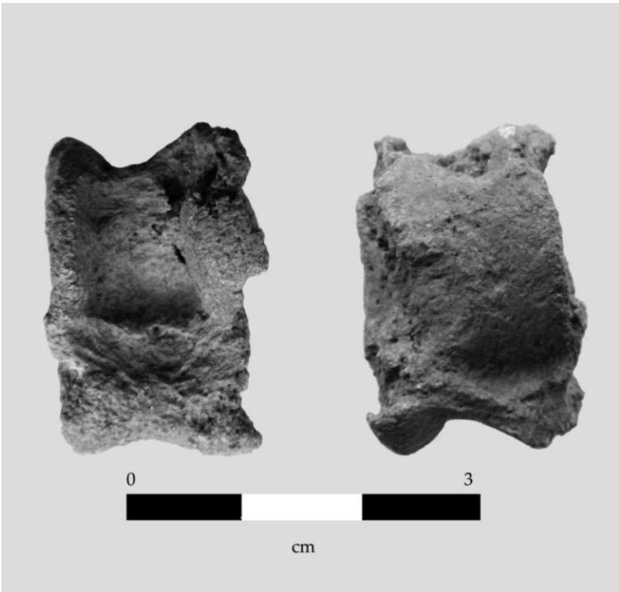

Figure 14: A partially digested caprid astragalus from F2.

Table 9: The length and breadth measurements (mm) of mandibular P2s to M3s of *Canis lupus familiaris* from Vasino compared with reference materials from the UP ASP collection. (l = length, b= breadth). The reference materials have the accession codes starting with A-.

Code	Side	P2l	P2b	P3l	P3b	P4l	P4b	M1l	M1b	M2l	M2b	M3l	M3b
Mandible													
D2	L	\	\	\	\	\	\	\	\	7.55	5.71	\	\
D3	L	\	\	\	\	\	\	19.23	3.88	\	\	\	\
D4	R	\	\	\	\	\	\	\	\	\	\	5.53	4.02
D6	R	7.37	3.83	\	\	10.09	5.19	17.97	4.96	7.35	5.56	\	\
A-034a	L	8.16	4.23	8.86	4.3	10.06	5.08	18.75	3.33	7.88	5.89	4.3	4.15
A-034b	L	8.56	4.98	9.28	4.66	10.22	5.47	19.07	3.79	7.41	5.91	5.12	4.31
A-112	L	8.24	4.12	9.45	4.32	10.45	5.48	19.57	3.79	8.85	5.4	5.2	4.63
A-066	L	8.01	4.16	9.49	4.37	9.81	5.24	19.6	4.43	8.11	6.52	5.13	4.78

Figure 15: A goat calcaneus from D4 with lateral and medial indentations caused by compression by dog canines.

An upper left canine from an adult male long-tailed macaque *Macaca fascicularis* along with a worn dp4 from a sub-adult were recovered just below the topsoil in A2. A right premaxilla (Figure 16) and a heavily worn left mandibular M1 were recorded from D5 and F2 respectively.

A single sea turtle phalanx was recovered from G3 (Figure 17). Likewise, a single snake vertebra was recorded from E2. Murid, cuscus (*Phalanger orientalis*) and bird, particularly chicken, remains were notably absent from the assemblage. Human teeth were recorded from Pit G, including two incisors from G2, and an upper molar from G4.

Figure 16: A *Macaca fascicularis* right premaxilla from D5

Figure 17: A marine turtle phalanx from G3

Two conjoining fragments of what is possibly a portion of bracelet were recorded from D5 (Figure 18A). The fragments have a curving (outer) dorsal surface and flat (internal) ventral surface. The joined fragments have a maximum length of 32.6 mm and a maximum width of 5.97mm. A similar ornament, made of shell, was recorded from C3 (Figure 18 B). It has an internal diameter of 30.85 mm, total length of 44.21 mm, width of 6.95 mm, thickness of 2.79 mm and a highly polished, u-shaped outer surface. One end of the fragment appears to have been ground and polished, suggesting that the ornament was not a full circle.

Figure 18: Polished bone ornament recovered from D5 (A) and a shell ornament, probably a bracelet fragment from C3 (B) (Scale in cms)

DISCUSSION

Taphonomy: The distribution of faunal remains indicates that the north central area (Pits C and D) of the lower platform at Vasino seems to have been a focus for the deposition of animal bones. Even taking into possible disturbance, especially in Pit D, it is unlikely that this resulted in the wholesale re-distribution of faunal remains into the Pit C and D area of the site. Not only was the highest proportion of animal remains recovered from these two pits, but the preservation was much better with larger and hence more identifiable fragments recovered. High proportions of weathered bone within the subsurface layers reflect the shallowness of bone burial on the site as does the extensive root-etching demonstrated by some fragments. Differential weathering of some skeletal elements, especially in Pits C and D, suggests they have been subjected to little if any post-depositional re-working since their burial. It is intriguing to note that Pits C and D were located close to teh most sacred spots on the site according to local informants: the tei and the grave of a founding ancestor. The bone assemblage was certainly densest at this location and it is possible that this could have been the past location of animal sacrifices in the past. Even at the end of the 2009 excavations it was this location that the local inhabitants chose to sacrifice the animals (Jack Fenner, personal communication 2011).

The butchery evidence indicates that the carcasses of pigs, goats and Bovinae were being systematically disarticulated to produce smaller carcass units. Interpreting the exact methods of dressing carcasses is not possible from the evidence produced from the zooarchaeological record, but some of the techniques used were removal of the head, the scapula from the humerus, the humerus from the radius and ulna and detachment of the whole foot at the calcaneus. There is evidence of many high and low meat yielding skeletal elements in the assemblage implying that whole carcasses were being dressed on site.

Gnawing and digestion were recorded throughout the bone assemblages suggesting that dogs were probably free-ranging and had access to relatively fresh skeletal remains before they were buried.

Overall the taphonomic evidence would suggest that the faunal assemblage represents a human-derived midden that has accumulated on or close to the ground surface. The weathering and dog ravaging would seem to indicate some initial delay between deposition and eventual burial as materials built up.

Species Representation: Pig bones are recovered throughout the archaeological sequences at Vasino. Glover (1986: 197) has argued that in his excavations the pig was consistently the earliest introduced animal to East Timor between 5,000 and 4,000 cal. BP. It is traditionally believed that pigs were introduced to the Lesser Sunda Islands by migrating Neolithic populations who originated from the mainland of Southeast Asia (e.g. Bellwood, 1997) but recent population genetics and ancient DNA studies have demonstrated the complexity of pig translocations in the region. For example, Larson *et al.* (2007) identified two introductions of pigs at the cave site of Liang Bua on Flores, the initial translocation involving the Sulawesi warty pig (*Sus celebensis*) as long ago as 7,000 cal. BP. This was followed by the domesticated Eurasian wild boar (*Sus scrofa*) associated with Neolithic material culture between 4,000 and 3,500 BP. Larson *et al*. (2007) also identified both domesticated *S. scrofa* of the Pacific Clade lineage similar to those translocated from the Mainland through Island Southeast Asia into Melanesia and the Pacific, and a single specimen with a maternal lineage from *S. celebensis* on Timor in modern DNA samples. This makes allocation to species for the Vasino pigs difficult. The small body size and age at death profile would suggest that they are more likely to be from domesticated pig breed. Geometric morphometric analyses of the molar teeth could help elucidate the taxonomy of the Vasino pigs but this would require a much larger sample size than has already been excavated.

Zooarchaeological records of goat are scarce throughout Mainland and Island Southeast Asia. In East Timor itself, Glover (1986: 205) reported that *Capra/Ovis* remains first appear in the archaeological sequence in the cave of Uai Bobo 2, in Horizon VII (5,000 – 6,000 BP) and Horizon IX (3,500 – 4,000 BP). He also noted that goat bones were recovered in quantity only at Uai Bobo 1 Horizon V and at Uai Bobo 2 in Horizon X which are dated to about 1,400 – 1,800 and 2,000 – 2,500 BP respectively. The authors regard all these dates as probably too early for the introduction of the goat to the region, especially considering *capra/ovis* only appear in the zooarchaeological record of China at 4,000 cal. BP and then only in small numbers (Jing and Flad, 2002), and no goat bones of this date have yet been recorded in Neolithic sites in the Philippines, Vietnam (e.g. Piper *et al.*, 2009; Piper *et al.*, 2010 unpubl.) or Thailand (Kijngam, 2010). An explanation for these early records of goat might be that a common contemporary use of caves is for goat herding pens (Sue O'Connor *personal communication* 2010). This practice is possibly of some antiquity and caused considerable disturbance and re-working of goat bones into old deposits.

The exact origins and timing for the introduction of the goat to Island Southeast Asia remains unresolved. A recent study of animal bones from the Batanes Islands in the northern Philippines recorded goat in deposits post-dating the earlier half of the first millennium AD, and the goat seems to succeed some of the earliest evidence for the introduction of Chinese porcelain on the islands (Piper *et al*. in prep.). Patterns of long-distance Chinese trade began to emerge in the latter part of the first millennium BC and early centuries AD and then intensified towards the mid-late first millennium AD, and this latter period appears to coincide with the first appearance of the goat on the Batanes Islands.

The archaeological research at Vasino has clearly demonstrated that goats were present in East Timor by the 14th or 15th Century AD (with specimens recorded in Pit C Layer 4 dated to the end of the 14th or early 15th Century AD). This probably does not represent the earliest introduction of goat to Timor, but it does fit neatly with the 15th and 16th Century AD accounts of Antonio Pigafetta (1969), the chronicler of Magellan who noted that

"In [Timor], and nowhere else, is found white sandalwood, besides ginger, swine, goats, rice… wax, and other things, and parrots of divers sorts and colours."

Cattle and buffalo are also recorded in the earliest archaeological sequences at Vasino. Glover (1986) placed the introduction of Bovinae to East Timor at around 1500 BP, but this is very uncertain and concrete evidence for the remains of introduced Bovinae across Island Southeast Asia is rare. Van den Bergh *et al*. (2009) report that diagnostic remains of cattle were only recovered from the upper 50 cm of deposit at Liang Bua cave on Flores and correspond to dates within the last 500 years. They argued that Bovinae were probably introduced by the Portugese to Flores. New records from Vasino indicate that Bovinae were also present in East Timor by the 14th or 15th Century AD. The dates and the complete absence of glass and trade wares (O'Connor *et al.,* in press) from Vasino suggest that the introduction of Bovinae to Timor more than likely pre-dates European contact.

Though it is not impossible that the inhabitants of Vasino hunted a predominance juvenile and sub-adult pigs (see arguments in Albarella *et al*., 2006) it is more likely that the suid remains represent domestic stock maintained around the fortified site rather than hunted animals. Although it is difficult to be certain whether the buffalo and cattle remains are those of domestic or feral stock, a 15 m diameter circular stone walled structure found in the upper level of Vasino was identified by local informants as a water buffalo corral, which implies buffaloes were maintained within the Vasino site. Historical accounts also mention the dependence of Timorese on water buffaloes as work animals, particularly in rice agriculture (Dampier, 1729).

William Dampier (1703: 170), who visited the north coast of East Timor in 1699, noted:

"*Their plantations are very mean; for they delight most in hunting; and here wild buffaloes and hogs enough, though very shy, because of their so frequent hunting*".

Sue O'Connor (*personal communication* 2011) reported that contemporary human communities of East Timor maintain herds of goats of up to 50 individuals that are ranging free during the day under the watchful eye of a shepherd and penned at night. Individual households possess perhaps one or two sows and several individuals ranging from piglets to young adults. Large herds of cattle and buffaloes are also seen and these are often owned by the community. This description fits relatively well with the zooarchaeological evidence and suggests these systems of animal management are perhaps of some antiquity.

The complete absence of some wild animals, such as the northern common cuscus (*Phalanger orientalis*) and common palm civet (*Paradoxurus hermaphroditus*) and the scarcity of deer, macaque, turtle and snake suggests that hunting did not play a major role in the diet of the inhabitants' of Vasino and they probably relied more heavily on domestic animals.

The presence of bones with dog gnawing and digestion might indicate that dogs roamed freely around the site picking up discarded food refuse. Thus the scarcity of fish remains cannot be used to argue that the inhabitants of Vasino did not have access to marine fish. Piper *et al.* (2010) have argued that the presence or absence of fish bone in an archaeological site might be related to dog ravaging, rather than an indication of whether people were or were not participating in fishing activities. For example, Jones (1984, 1986) and Nicholson (1993) fed dog, rat, pig and humans several different fish species and showed that between 85% and 100% of the skeletal elements originally identifiable in the fish skeleton were lost during the digestive process. In similar experiments Butler and Shroeder (1998) recorded a slightly less attrition of through human digestion of 74%.

According to Portuguese accounts (e.g. de Zarsedas, 1811), dogs were used as a food resource and were slaughtered sometimes as ceremonial offerings. The scarcity of dog bones and the absence of butchered dog bone leave the question of dogs in the human diet on Timor open to further research, but recent studies into Neolithic subsistence in southern Vietnam (Piper *et al*., in press) and the northern Philippines (Piper *et al*., in prep.) has confirmed that dogs were eaten during antiquity in Island Southeast Asia.

Glover (1986: 205) found two canines in his excavation of Bui Ceri Uato that fall morphometrically outside the range of those of typical Melanesian and Southeast Asian dogs. He also found a mandible that has an alveolar groove in the lingual side which he considered a "*characteristic of the dingo but not of the Melanesian dog*". The teeth recovered from Vasino fall in the size range of those of modern day Southeast Asian dogs (from the measurements of at least 43 individuals). Also, alveolar distances in the mandible recovered from D6 were not significantly different from those of native Philippine dogs kept at the UP-ASP Zooarchaeology collection. It is possible that the remains reported by Glover (1986) represent a different population from the Vasino dogs. Currently, the oldest known canid remains on Timor are from a dog burial excavated from the cave Matja Kuru 2 and directly dated to 2967 ± 50 bp (uncalibrated) suggesting a long history of domestic dogs on the island (Veth *et al*., 2005).

The absence of murid remains in the assemblage is also notable. Giant rats have been reported in pre-Neolithic layers in East Timor (i.e. Veth *et al.*, 2005). Recently, Aplin (2010) recovered the remains of giant rats, one of which was identified as a new species of the genus *Coryphomys* and was dated to as recently as 1000 years BP. In his excavation of four cave sites in East Timor (Lie Siri, Bui Ceri Uato, Uai Bobo1 and Uia Bobo 2) Glover (1986) recovered more than 90,000 murid bones, mostly from *Rattus exulans* and *Melomys*. The location of Vasino on a hilltop and its intensive human occupation and high encircling walls could account for the rarity in endemic murid remains (though commensal taxa might be expected), and the presence of scavenging dogs could also have influenced preservation. It is also possible that many of the large endemic species were extinct before the development of the Vasino fortification in the 14th – 15th Centuries AD.

CONCLUSION

Zooarchaeological analyses of the animal bones from Vasino suggest that Pits C and D in the central north area of the lower level within the fortification were located where a midden of discarded bone fragments accumulated. The bones were not immediately buried but deposited on the ground surface where they often weathered and/or were gnawed by free-ranging dogs before eventual burial. This is the location of the most sacred area within the Vasino fortification, and it is possible that the high bone concentrations in this area is not coincidence and perhaps represents the area where offerings were made to the *Tei* and founding ancestor.

There is no clear evidence within the zooarchaeological record that hunting was a principal component of subsistence strategies during the occupation of Vasino though some species such as deer, macaques and reptiles were occasionally being introduced to the site, perhaps with some feral pigs and cattle.

The inhabitants of Vasino primarily maintained populations of domestic pigs, goats and cattle/buffalo throughout the 14th-17th centuries AD. The present subsistence strategy of maintaining herds of goats, pig populations dominated by juveniles and sub-adults and herds of buffalo and cattle is a relatively good analogy for the economy of the inhabitants of Vasino. Skeletal element representation and butchery practices indicate that carcasses of animals were being dressed within the boundaries of the fortification.

REFERENCES

Albarella U, Dobney K and Rowley-Conwy P. 2006. In *The domestication of the Pig (Sus scrofa): New Challenges and Approaches*, Zeder MA, Bradley DG, Emshwiller E, and Smith BD (eds.). University of California Press: Berkeley: 209-227

Andrews, P.J. & Nesbit Evans E.M. 1983. Small mammal bone accumulations produced by mammalian carnivores. *Paleobiology* 9: 289-307.

Aplin, K. 2010. Quaternary murid rodents of Timor Part I: New material of *Coryphomys buehleri* Schaub, 1937, and description of a second species of the Genus. New York: *Bulletin of the American Museum of Natural History* 341: 1-80.

Bellwood, P. 1997 (2nd Edn). *Prehistory of the Indo-Malaysian Archipelago*. Honolulu: University of Hawaii Press.

Bull, G. & Payne, S. 1982. Tooth eruption and epiphyseal fusion in pigs and wild boar. In Wilson, B., Grigson, C., and Payne, S. (eds.), Ageing and Sexing

Animal Bones from Archaeological Sites. Oxford: *British Archaeology Reports British Series* 109: 55-71.

Butler, V.L. & Schroeder, R.A. 1998. Do digestive processes leave diagnostic traces on fish bones? *Journal of Archaeological Science* 25: 957-971.

Dampier, W., 1703. *A new voyage round the world; Describing particularly, the Isthmus of America, several coasts and islands in the West Indies, the Isles of Cape Verd, the passage by Terra del Fuego, the South Sea coasts of Chile, Peru, and Mexico, the Isle of Guam one of the Ladrones, Mindanao and other Philippine and east India islands near Cambodia, China, Formosa, Luconia, Celebes andc., New Holland, Sumatra, Nicobar Isles, the Cape of Good Hope, and Santa Hellena: their soil, rivers, harbours, plants, fruits, animals, and inhabitants: their customs, religion, government, trade and c.* Vol. 1. London: Knapton.

Dampier, W. 1729. A Continuation of a Voyage to New Holland, etc. In the year 1699. Wherein are described, The Islands Timor, Roti and Anabao. A passage between the islands Timor and Anabao. Kupang and Laphao Bays. The islands Omba, Fetter, Banda and Bird. A description of the coast of New Guinea. The islands Pulo Sabuda, Cockle, King William's, Providence, Gerrit Denis, Anthony Cave's and St. John's. Also a new passage between New Guinea and New Britain. The islands Ceram, Bonao, Bouro, and several islands before unknown. The coast of Java, and Straits of Sunda. Author's arrival at Batavia, Cape of Good Hope, St. Helena, island of Ascension, etc. Their inhabitants, customs, trade, etc. Harbours, soil, birds, fish, etc. Trees, plants, fruits, etc. London: James Knapton.

Davis, S.J. 1985. Carnivore remains from the excavation of the Jericho tell. In P. Ucko and G. Bimbleby (Eds.), *The domestication and exploitation of plants and animals.* London: Duckworth [page no.s].

De Sarzedas. Vitorino Friere da Cunha Gusmao, 28 Abril 1811, in Solor e Timor, Agencia Geral das Colonias, Lisboa, 1943.

Dobney, K., Ervynck, A., Albarella, U. & Rowley-Conwy, P. 2007. The transition from wild boar to domestic pig in Eurasia, illustrated by a tooth developmental defect and biometrical data, in U. Alberetta, K. Dobney, A. Ervynck and P. Rowley-Conwy (eds.). *Pigs and humans: 10,000 years of interaction*. Oxford: Oxford University Press: 57-82.

Ervynck, A. & Dobney, K. 1999. Lining up on the M1: a tooth defect as a bio-indicator for environment and husbandry in ancient pigs. *Environmental Archaeology* 4: 1-8.

Genov, P.V. 2004. Craniometric Characteristics of the Subgenus *Sus* Linnaeus, 1758 and a Systenmatic Conclusion. *Galemys* 16: 9-23.

Glover, I. 1986. *Archaeology in East Timor 1966–67.* Canberra: Department of Prehistory, Research School of Pacific Studies, Australian National University. *Terra Australis* 11.

Grant, A. 1982. The use of tooth wear as a guide to the age of domestic ungulates. In B. Wilson, C. Grigson and S. Payne (eds.), Ageing and Sexing Animal Bones from Archaeological Sites. Oxford: *British Archaeology Reports British Series* 109: 91-107.

Habermehl, K.H. 1975. *Die Alterbestimmung bei Hausund Labortieren*. Berlin: Paul Parey.

Hillson, S. 2005. *Teeth*, Cambridge: Cambridge University Press.

Jing, Y. & Flad, R.K. 2002. Pig domestication in ancient China. *Antiquity* 76: 724-732.

Jones, A.K.G. 1984. Some effects of the mammalian digestive system on fish bones, in N. Desse-Berset (Ed.), *2nd fish osteoarchaeology meeting, Paris: Centre National de la Recherche Scientifique,* Centre de Recherches Archeologiques et Monographies Techniques 16: 61-65.

Jones, A.K.G. 1986. Fish bone survival in the digestive systems of pig, dog and man, in D. Brinkhuizen and A. Clason (Eds.), Fish and archaeology. Oxford: *British Archaeological Reports, International Series* 294: 53-61.

Kijngam, A. 2010. The mammalian fauna, in C.F.W. Higham and A. Kijnham (Eds.), *The origins of the civilization of Angkor Volume IV: The excavation of Ban Non Wat: The Neolithic occupation*. Bangkok: The Fine Arts Department: 189-196.

Larson, G., Cucchi, T., Fujita, M., Matisoo-Smith, E., Robins, J., Anderson, A., Rolett, B., Spriggs, M., Dolman, G., Tae-Hun Kim, Nguyen Thi Dieu Thuy, Randi, E., Doherty, M., Rokus Awe Due, Bollt, R., Djubiantono, T., Griffin, B., Intoh, M., Keane, E., Kirch, P., Kuang-Ti Li, Morwood, M., Pedriña, L., Piper, P.J., Rabett, R.J., Shooter, P., Van den Bergh, G., West, E., Wickler, S., Yuan, J., Cooper, A. & Dobney, K.. 2007. Phylogeny and Ancient DNA of *Sus* Provides New Insights into Neolithic Expansion in Island Southeast Asia and Oceania. *Proceedings of the National Academy of Sciences USA* 104 (12): 4834-4839.

Lyman, R. L. 1994. *Vertebrate Taphonomy*. Cambridge: Cambridge University Press.

Nicholson, R.A. 1993. An investigation into the effects on fish bone of passage through the human gut: some experiments and comparisons with archaeological material. *Circaea* 10: 38-51.

Moran, N. C. & O'Connor, T. P. 1994. Age attribution in domestic sheep by skeletal and dental maturation: a pilot study of available sources. *International Journal of Osteoarchaeology* 4: 267–28.

O'Connor, S., McWilliam, A., Fenner, J. & Brockwell, C. in press. Fortification of East Timor: Social, economic and environmental factors. *Journal of Anthropological Archaeology*.

Payne S. & Munson, J. 1985 Ruby and how many squirrels ? The destruction of bones by dogs. In N.R.J. Fieller, D.D. Gilbertson and N.G.A. Ralph (Eds.), *Paleobiological Investigation.* . BAR British Series 266. Oxford: British Archaeology Reports: 31-48.

Pigafetta, A. 1969. *Magellan's Voyage: A Narrative Account of the First Circumnavigation.* New Haven and London: Yale University Press.

Piper, P.J., 2003. *Rodents, Reptiles and Amphibians: The palaeoecological and taphonomic study of small vertebrate remains from archaeological settlement sites*, Unpublished PhD thesis, University of York.

Piper, P.J., Campos, F.Z. & Hung, H-c. 2009. A study of the animal bone recovered from Pits 9 and 10 at the site of Nagsabaran in northern Luzon, Philippines. *Hukay* 14: 47-90.

Piper, P.J., Campos, F.Z., Kinh, D.N. & Amano, N. 2010. A Report on the animal remains from the 2009 archaeological excavations at An Son, Duc Hoa, District, Vietnam. Unpublished report.

Piper, P.J., Campos, F., Kinh, D.N., Amano, N., Oxenham, M., Hoang, B.C., Bellwood, P. & Willis, A. in review. Early evidence for pig and dog husbandry and the Neolithic site of An Son, southern Vietnam. *International Journal of Osteoarchaeology*.

Piper, P.J., Amano Jr., N., Yang, H-Y. & O'Connor, T.P. in prep. The terrestrial vertebrate remains, in P. Bellwood and E. Dizon (Eds.), *Archaeology in the Batanes Islands: The earlu movements of Austronesian-speaking populations.*

Silver, I.A. 1970. The ageing of domestic animals. in D.R. Brothwell and E.S. Higgs (Eds), *Science in Archaeology: A Survey of Progress and Research*. 2nd ed. Pp. 283-302. New York: Praeger Printing.

Veth, P., O'Connor, S. & Spriggs, M. 2005. Continuity in tropical cave use: Examples from East Timor and the Aru Islands, Maluku. *Asian Perspectives* 44(1): 180-192.

van Bree, P.J.H., van Soest, R.W.M., & Strongman, L. 1974. Tooth wear as an indication of age in badgers (*Meles meles*) and red foxes (*Vulpes vulpes*). *Zeitschrift fur Saugetierk* 39: 243-248.

van den Bergh, G., Rokus Due Awe, Meijer, H.J.M, Szabó, K., van den Hoek Ostende, L.W., Morwood, M.J., Sutikna, T., Saptomo, E. W., Piper, P.J. & Dobney, K.M. 2009. The Liang Bua faunal remains: a 95 kyr sequence from Flores, East Indonesia. *Journal of Human Evolution* 57: 527-537.

Von den Driesch, A. 1976. *A Guide to the Measurement of Animal Bones from Archaeological Sites*, Cambridge, Massachusetts, Peabody Museum of Archaeology and Ethnology, Bulletin No. 1.